3.0 PROJECT OPERATIONS

3.1 HOW THE POWERPLANTS WORK

Releases from Lake Oroville are routed through the Edward Hyatt Powerplant into the Feather River for power generation. Releases above Feather River instream requirements are then diverted from the Feather River into the Thermalito Forebay. The water not diverted from the Feather River at this point is discharged through Thermalito Diversion Dam Powerplant. The water in the Thermalito Forebay is routed through the Thermalito Pumping-Generating Plant into Thermalito Afterbay. Inflow to Thermalito Afterbay from peak power generation, in excess of local and downstream requirements, is stored for later release to the river. If energy price and availability factors are favorable the water stored in Thermalito Afterbay may be pumped back through Thermalito Pumping-Generation Plant and Edward Hyatt Powerplant into Lake Oroville during off-peak hours. A pump-back operation most commonly occurs when energy prices are high during weekday on-peak hours (when water is released for power generation) and low during the weekday off-peak hours or on the weekend (when water is pumped back into Lake Oroville for later power generation).

Local water supply diversions take water directly from the Thermalito Afterbay. The total capacity of Afterbay diversions during peak periods of peak water supply demands is 4,050 cfs. The Oroville Thermalito Complex has a capacity of approximately 17,000 cfs through the powerplants, which can be returned to the Feather River via the Afterbay's river outlet.

3.2 POWER EXCHANGE

Overall, the SWP uses more energy than it produces. To balance SWP loads with available resources, DWR relies upon a suite of options that include purchases from the Power Exchange, day-ahead, and hour-ahead markets; capacity exchanges; and energy contracts (both short and long-term). Two such contracts with Southern California Edison Company (SCE) allow DWR to exchange on-peak capacity and energy for off-peak energy that may be used elsewhere within the SWP system. Specifically, under the terms of the 1979 Power Contract and the 1981 Capacity Exchange Agreement, DWR provides SCE with up to 350 MW of capacity and approximately 40 percent of the energy from Hyatt-Thermalito. In return, DWR receives off-peak energy from SCE equal to the amount of energy provided to SCE from Hyatt-Thermalito, plus an additional amount of energy as payment for the capacity. The amount of additional energy is

determined annually based on the Capacity-Energy Exchange Formula defined in the 1979 Power Contract.

3.3 LOAD MANAGEMENT

The SWP controls the timing of its pumping load through an extensive computerized network. That control system allows DWR to minimize the cost of power it purchases by maximizing pumping during off-peak periods when power costs are lower—usually at night—and to sell power to other utilities during on-peak periods when power values are high. By taking advantage of this flexibility in scheduling SWP pumping load and generation, DWR reduces the net cost for SWP water deliveries.

When generation from the Oroville Facilities exceeds SWP load requirements, DWR sells the excess power on the market. Currently, DWR contracts with utilities and marketers for short-term purchase, sale, or exchange of power. In addition to selling firm power, DWR may sell power on a day-to-day or hour-to-hour basis according to the terms of its interchange agreements and of the Western System Power Pool agreement. These agreements provide the basis for making economy energy transactions, short-term capacity and energy sales or exchanges, unit commitments, and transmission service purchases. Through these contracts, DWR sells excess capacity and energy at market rates.

3.4 ANNUAL GENERATION DATA

Economic hydroelectric generation provides the largest share of SWP power resources. However, hydroelectric generation at the Oroville Facilities is greatly affected by the amount of annual runoff to the Feather River watershed. The combined 762 MW Edward Hyatt Powerplant and Thermalito Pumping-Generating Plant generate about 2.2 billion kWh in a median water year (DWR 1999). The three MW from the Thermalito Diversion Dam Powerplant adds another 24 million kWh a year. Over the past 16 years, the range of generation has varied from below 1,000,000 MW-hours in 1991 and 1992 (critically dry years) to over 3,700,000 MW-hours in 1995 (a very wet year). Figure 3-1 summarizes annual generation at the Oroville Complex for the past 16 years.

Click here to access Figure 3-1

3.5 RESERVOIR OPERATIONS

Lake Oroville can store about 3.5 maf of water at maximum capacity. Figure 3-2 depicts the area and capacity (volume) versus elevation curves for Lake Oroville.

Operations of the Oroville Facilities are planned and scheduled in concert with other SWP facilities. Its waters meet local and downstream demands when unregulated flows alone are not enough to satisfy those needs. It plays an important role in protecting lives and property downstream along the Feather and Sacramento rivers during periods of high flow. In addition, it enables DWR to offset some of the high costs associated with operating the SWP through electrical generation at its powerplants. Operation of the complex varies seasonally, weekly, and hourly depending on hydrology and the objectives that DWR is trying to meet. Typically, releases to the Feather River are managed to conserve water while meeting instream, Sacramento-San Joaquin Delta, and SWP requirements including flow, temperature, fisheries, recreation, water quality, and diversion.

Planning for and implementing the operations of the SWP is highly dependent on constraints placed upon the Oroville Facilities. The SWP's operations decision-making is a stepwise process that begins with an overall plan for the year. This long-range plan is used to establish general operational objectives and to assess the likelihood of achieving these objectives. On a weekly basis, operations are planned that will result in the overall annual objectives being achieved. Daily schedules are developed to achieve the weekly operational objectives and are adjusted in real-time as needed to respond to changes in conditions. The Oroville-Thermalito Complex operational planning is performed within DWR headquarters by the Operations Control Office (OCO). The day-to-day operation of the Oroville Facilities is done through the Oroville Field Division (OFD).

3.5.1 Flood Control Requirements

The Oroville Facilities are an integral component of the flood control system for the surrounding area. During the wintertime, the Oroville Facilities are operated under flood control requirements specified by the U.S. Army Corps of Engineers (USACE). Under these requirements, Lake Oroville is to be operated to maintain up to 750,000 acre-feet of storage space to allow for the capture of significant inflows. Flood control releases are

Click here to access Figure 3-2

determined by the release schedule in the flood control manual and by consultation with the USACE.

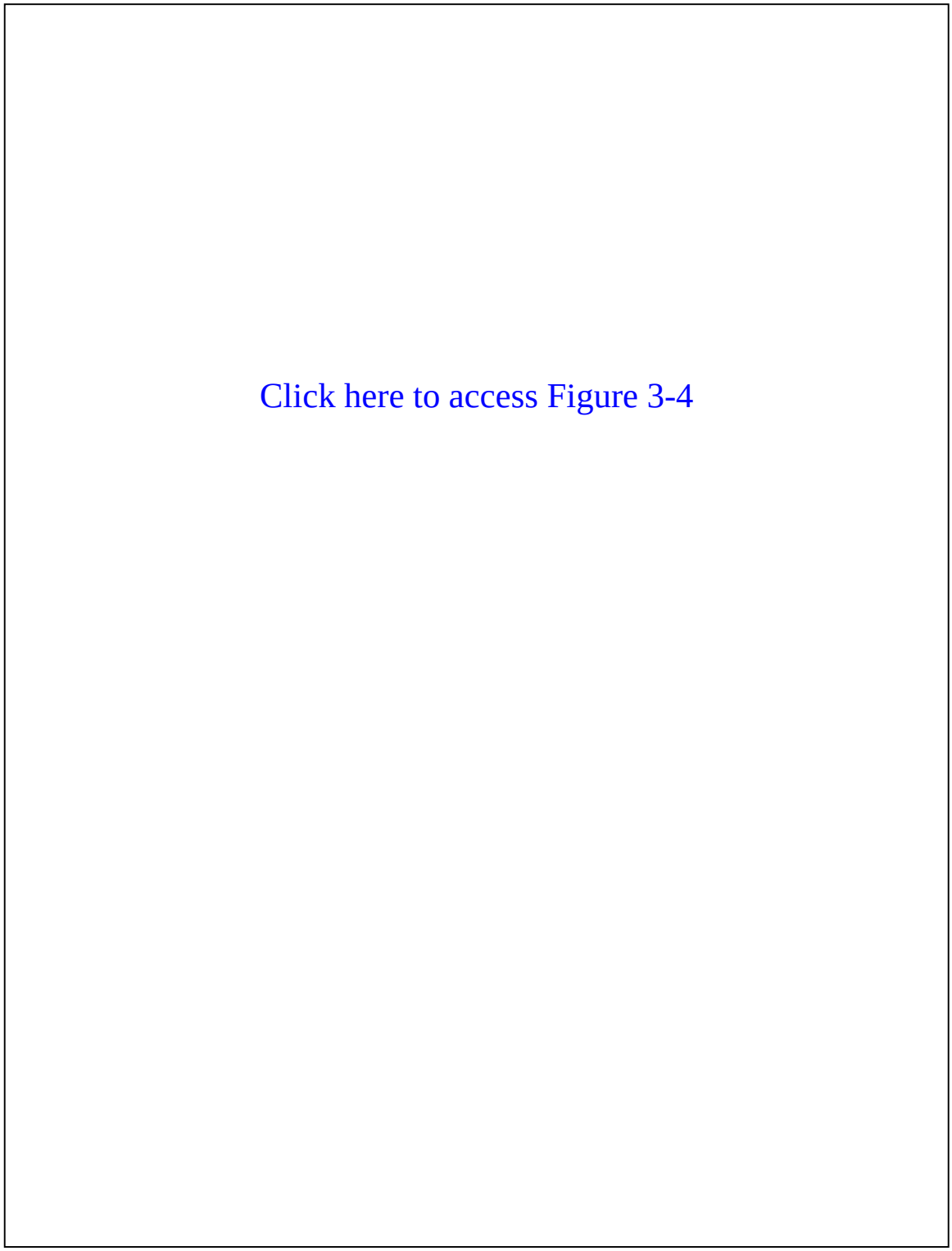
The flood control diagram is designed for multiple use of reservoir space. During times when flood control space is not required to accomplish flood control objectives, reservoir space can be used for storing water. Figure 3-3 is an example flood control diagram for October 1, 1999 through December 31, 2000.

From October through March, the maximum allowable storage limit varies from about 2.8 to 3.2 maf to ensure adequate space in Lake Oroville to handle any flood flows. The actual limit is based on a wetness index, computed from accumulated basin precipitation. This allows DWR to maintain Lake Oroville at a higher level when the prevailing hydrology is dry while maintaining adequate flood protection. When the wetness index is high (i.e., wetness in the basin is high), the flood control space required is at its greatest amount to provide the necessary flood protection. From April through June, the maximum allowable storage limit is increased as the potential from flooding decreases to allow capture of the higher spring flows for use later in the year. During September, the maximum allowable storage decreases again to prepare for the next flood season.

Figure 3-4 shows the Lake Oroville water levels for dry, average and wet water years. As seen in the figure, the shape of the actual operations follows the shape of the flood control diagram with:

- lower levels in the late winter and early spring for flood control purposes;
- higher levels in the late spring early summer as the higher flows are stored; and
- declining levels in the late summer and fall as the stored water is used.

Click here to access Figure 3-3


Click here to access Figure 3-4

The maximum allowable storage limits can be violated during flood events to prevent downstream flooding along the Feather River. Table 3-1 lists the maximum allowable flows at various locations along the Feather River.

Table 3-1: Maximum Feather River Flow Rates

Location	Max. Allowable Flow
Below Lake Oroville	150,000 cfs
Above Yuba River	180,000 cfs
Below Yuba River	300,000 cfs
Below Bear River	320,000 cfs

Table 3-2 presents the significant spills of record. The maximum release (excluding flows through the Edward Hyatt Powerplants) of 137,000 cfs is considerably below the peak inflow of 266,000 cfs associated with that release. The largest total release of over 2 maf occurred in 1996.

Table 3-2: Significant Spills of Record

Spill Begin	Period End	Maximum. Release in cfs	Total Release in af	Maximum Inflow in cfs
1-13-70	2-02-70	59,000	1,563,621	34,600
1-12-80	1-20-80	70,000	726,259	155,200
2-15-86	3-01-86	137,000	1,420,262	266,000
3-09-95	3-27-95	80,000	1,234,672	140,647
12-27-96	1-17-97	130,000	2,013,300	276,578

3.5.2 Downstream Requirements

As a major exporter of water from the Delta, the SWP must balance the water demands of its contractors with maintenance of the Delta's water quality requirements. To meet water contractor demands, water must be moved from Oroville into the Feather and Sacramento rivers and ultimately into the Delta. It takes approximately three days to move water from Oroville to the Delta and the amount moved depends on the time of year, export levels, and at times real time water quality conditions.

3.5.3 Annual Operations Planning

Operations planning requires a high degree of coordination with other agencies and must consider many factors. The OCO develops an annual operations plan that considers forecasted water supply, projected operations of the Central Valley Project, and regulatory (flood control, instream requirements, and water quality) and contractual obligations. The first official plan is completed in early December of each year as part of the "allocation process" and is a significant component in determining the amount of forecasted deliveries to state water contractors. This monthly time-step plan includes projected release to the Feather River, forecasts of Oroville inflow, Lake Oroville end-of-month storage, and local demands. The plan is updated each month through April to reflect changes in hydrology and downstream operations.

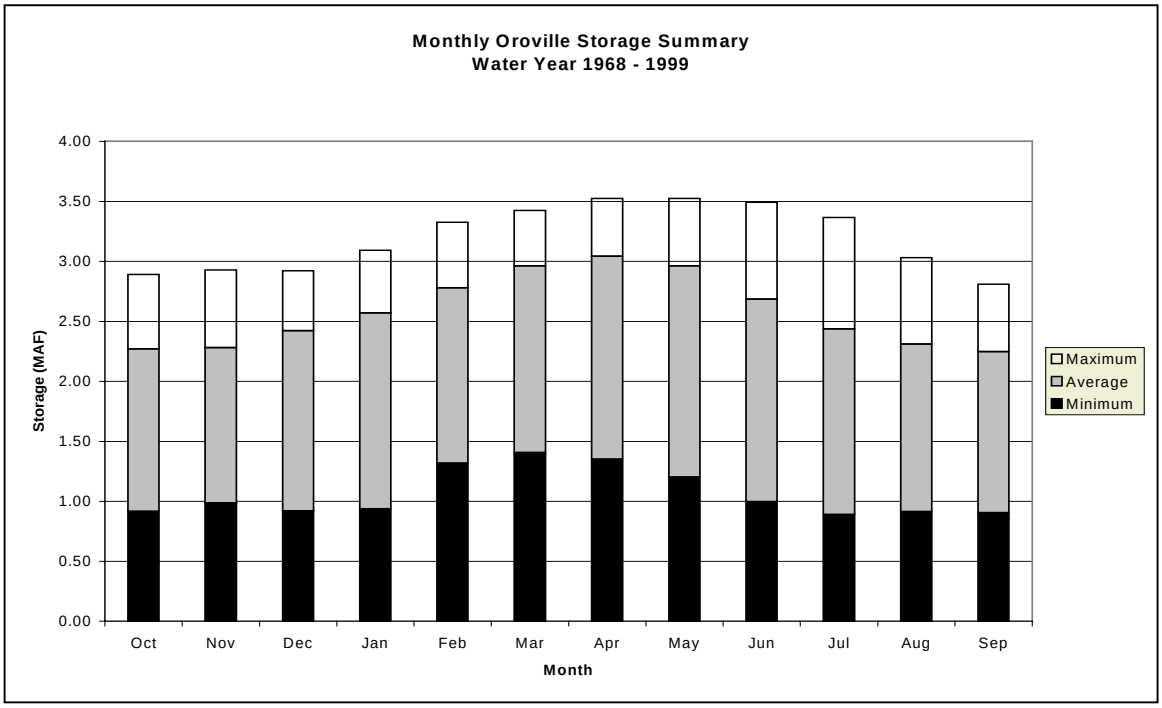
Figure 3-5 shows the minimum, average, and maximum mean monthly Oroville storage for water years 1968 to 1999. The difference in storage levels for any given month is indicative of the variability of hydrology and the effect that it has on annual operations planning. Typically, Lake Oroville is filled to its maximum annual level of up to 900 feet msl in June and then lowered as necessary to meet downstream requirements to its minimum level in December or January. During drier years, the lake may be drawn down more and may not fill to the desired level the following spring. For example, during 1991, 1992, and 1993, the minimum elevations were 651 feet, 702 feet, and 723 feet, respectively.

As part of the allocation process, not all of the forecasted Oroville storage is utilized during the current year's operation. It is assumed that only half of the available Lake Oroville storage above the minimum pool is used and the remaining half is stored for use in subsequent years. This ensures there will be some water to met the operational needs of the SWP in subsequent years in case of consecutive dry years.

3.5.4 Weekly Operations Planning

Each week, the OCO develops a general plan for reservoir releases. This plan considers how much water will be needed downstream for: (1) local demands; (2) SWP pumping requirements in the Delta; (3) Delta water quality and quantity requirements; (4) instream flow and temperature requirements; and (5) minimum flood control space. The weekly plan is revised as needed to respond to changing operational conditions both upstream and downstream.

Figure 3-5



3.5.5 Daily Operations Scheduling

On a daily basis, hourly releases through the powerplants are scheduled. The hourly operation through the plants is planned to maximize the amount of energy that may be produced during periods when electrical use is highest (and most costly). Additionally, ancillary services required for participation in the electric utility market and bid into the California Independent System Operator (CAISO) are also scheduled on an hourly basis. These services include spinning reserve, non-spinning reserve, supplemental energy market, and regulation. The hourly schedule may be manipulated in any fashion as long as it meets the overall daily Feather River release objective downstream of Thermalito Afterbay.

3.5.6 Thermalito Diversion Dam Pool

The Thermalito Diversion Dam Pool is the tailwater pool for the Edward Hyatt Powerplant and acts as a forebay when the powerplant is being utilized to pump water back into Lake Oroville. Water is diverted from the Diversion Dam Pool into the

Thermalito Power Canal for power generation at the Thermalito Pumping-Generating Plant. Additional water is diverted from the Thermalito Diversion Dam Pool into the natural channel of the Feather River where the water eventually flows to the Fish Barrier Dam and the Feather River Fish Hatchery.

3.5.7 Thermalito Forebay and Afterbay

The Thermalito Forebay is utilized to convey generating and pumping flows between the Thermalito Power Canal and the Thermalito Pumping-Generating Plant. The forebay additionally provides regulatory and surge damping for the Hyatt-Thermalito Power Complex for pumping and generating operation. Both the Forebay and Afterbay reservoirs are too small for seasonal storage so they are used primarily in weekly and daily operations planning.

The Thermalito Afterbay provides storage for pump-back operations; water used to generate electricity in excess of what is needed to meet downstream requirements can be pumped back into Lake Oroville during periods when energy prices are low. The afterbay also provides the means to maintain uniform flow in the Feather River downstream of the Oroville-Thermalito Facilities. It is also used to furnish water to local water districts in the Oroville area. All of these requirements must be taken into consideration when developing daily schedules for the Hyatt-Thermalito Powerplants.

Generally, the Hyatt-Thermalito Powerplants are operated to maximize the generation operation during the weekdays when power prices are highest. This usually results in higher storage in the afterbay by the end of the week. Generation at the Hyatt-Thermalito Powerplants is then decreased over the weekend, lowering the elevation of the afterbay, which prepares it for a similar operation the next week.

The Power Canal conveys flows between the Diversion Dam Pool and the Thermalito Forebay for operations at Thermalito Pumping-Generating Plant. Flow direction depends on whether the complex is being operated in pumping or generating mode. The Power Canal was designed to convey a maximum of 16,900 cfs for the generating cycle of pumped storage operation. Maximum flow in pump cycle is approximately 9,000 cfs.

3.5.8 Fish Barrier Dam Pool

Because of the relatively constant discharge of 600 cfs into the Fish Barrier Dam Pool from the Thermalito Diversion Dam Powerplant, the Fish Barrier Dam Pool remains at a

stable pool elevation. A notable exception to this is during periods of spill releases, when flood flows are routed through the Fish Barrier Dam Pool.

3.6 FLOW AND TEMPERATURE REQUIREMENTS

Minimum flows in the Lower Feather River are established by a 1983 agreement between DWR and DFG, Concerning the Operation of the Oroville Division of the State Water Project for Management of Fish & Wildlife. The agreement establishes criteria for flow and temperature for the Low Flow Channel of the Feather River and the reach of the Feather River below the Thermalito Afterbay outlet to the confluence with the Sacramento River for preservation of salmon spawning and rearing habitat.

The agreement specifies that DWR release a minimum of 600 cfs into the Feather River from the Thermalito Diversion Dam for fishery purposes. This is the total volume of flows from the diversion dam outlet, diversion dam powerplant, and the Feather River Fish Hatchery pipeline.

Table 3-3 lists the major minimum in-stream flow requirements on the Feather River below the Thermalito Afterbay return to the Feather River.

Table 3-3: Feather River Minimum Flow Requirements (1)

Percent of Normal (2) Runoff (%)	Oct – Feb (cfs)	Mar (cfs)	Apr – Sep (cfs)
> 55	1,700	1,700	1,000
< 55	1,200	1,000	1,000

(1) If Oroville surface elevation is greater than 733 feet.
(2) Normal is defined as the mean (1911 – 1960) April through July unimpaired runoff near Oroville of 1,942,000 acre-feet.

There is a requirement that if during October 15 through November 30 the hourly flow is greater than 2,500 cfs then the flow minus 500 cfs must be maintained until the following March unless the high flow was due to flood control operation or mechanical problems. This requirement is to protect any spawning that could occur in overbank areas during the higher flow rate by maintaining flow levels high enough to keep the overbank areas submerged. In practice, the flows are maintained below 2,500 cfs from October 15 to November 30 to prevent spawning in the overbank areas.

The agreement also specifies a narrative objective for water temperature below the Thermalito Afterbay river outlet and a numerical objective for temperatures of water provided to the Feather River Fish Hatchery. Below the Afterbay river outlet, temperatures must be suitable for fall-run salmon during fall months (after September 15). From May through August, temperatures must be suitable for shad, striped bass, and other warmwater fish. Under the agreement, the water supply for the Feather River Fish Hatchery must adhere to the following water temperature objectives (a deviation of plus or minus 4F° is allowed between April 1 through November 30):

Table 3-4: Water Temperature Objectives

Period	**Temperature** (°F)
April 1-May 15	51º
May 16-May 31	55º
June 1-June 15	56º
June 16-August 15	60º
August 16-August 31	58º
September 1-September 30	52º
October 1-November 30	51º
December 1-March 31	55º

Meeting the water temperature criteria is facilitated by a shutter controlled intake gate system at the dam that selects water for release from various reservoir depths, depending on the desired water temperature. Note that the National Marine Fisheries Service (NMFS) is proposing a new set of water temperature objectives that would provide colder water downstream for protection of steelhead and spring-run chinook salmon.

In addition to fish and wildlife obligations, a May 1969 agreement between DWR and Joint Water Districts obligates DWR to provide water at temperatures reasonably related to achieving agricultural production within the Joint Water District service area. Local rice farmers, whose interests are represented under the 1969 agreement, need warmer water during spring and summer for germination and growth of the rice (i.e., 65ºF from approximately April through mid-May, and 59ºF during the remainder of the growing season [Robbins, DWR, pers. comm., 2000]). DWR accommodates these farmers by releasing water that is as close as possible to the maximum temperature allowable under

the DFG-DWR agreement (i.e., 4ºF higher than the objectives stated above). Farmers often pond the water before flooding the rice fields to attain the desired water temperature.

3.7 PROPOSED OPERATIONAL CHANGES

At this time, no operational changes are proposed to the project; however, changes may be implemented as a result of the relicensing process.